

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
31 December 2003 (31.12.2003)

PCT

(10) International Publication Number
WO 2004/001621 A3

(51) International Patent Classification⁷: **G06F 15/173**

(74) Agents: **HODES, Alan, S. et al.; Morrison & Foerster LLP, 755 Page Mill Road, Palo Alto, CA 94304 (US).**

(21) International Application Number:
PCT/US2003/019674

(22) International Filing Date: 20 June 2003 (20.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/390,576 21 June 2002 (21.06.2002) US

(71) Applicant (for all designated States except US): **NEXTHOP TECHNOLOGIES, INC.** [US/US]; 825 Victors Way., Suite 100, Ann Arbor, MI 48176 (US).

(72) Inventor; and

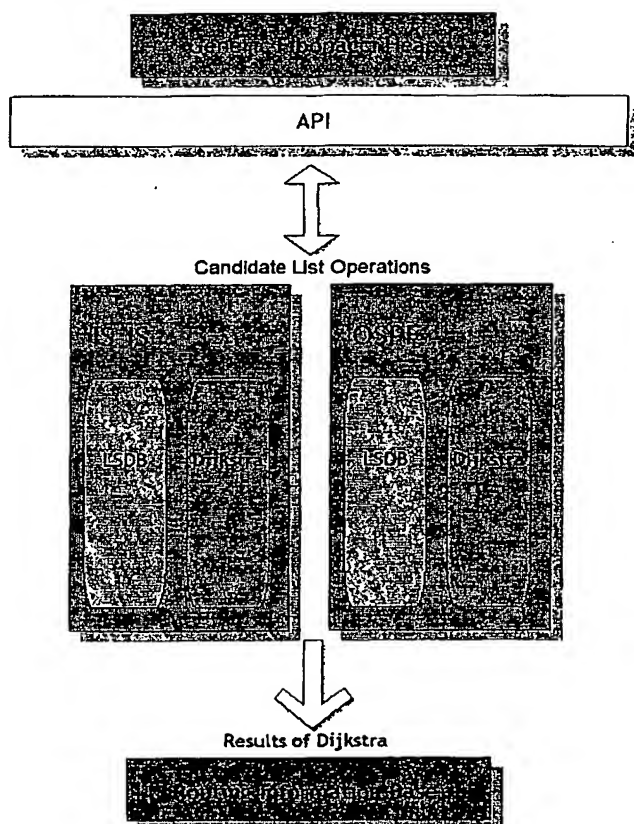
(75) Inventor/Applicant (for US only): **AMATO, Nicholas** [US/US]; 690 Canterbury Ct., Saline, MI 48176 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: **FIBONACCI HEAP FOR USE WITH INTERNET ROUTING PROTOCOLS**



(57) Abstract: In accordance with an aspect of the invention, one or more shortest paths is determined through a portion of a computer network, from a source vertex to one or more destination vertices according to a link-state protocol. A graph representation of the network portion is processed. The graph representation includes nodes and edges representing the vertices and connections therebetween. The processing includes operating on the graph representation according to a Dijkstra-like algorithm. A subset of the Dijkstra-like algorithm processing includes candidate list processing, to maintain and operate upon a candidate list (OSPF, IS-IS) of nodes that have been visited in the Dijkstra-like algorithm processing. Finally, the candidate list processing is optimized relative to standard Dijkstra algorithm processing for the link-state protocol. The optimized candidate list processing may be, for example, such that the candidate list processing operates on a candidate list of nodes that is stored in a generic format, as a Fibonacci heap of Fibonacci nodes in a generic format that is independent of the link-state protocol. Furthermore, the candidate list processing may be accessible via a generic application programming interface (API). As a result, the candidate list processing is useable for various link-state protocols, including various link-state routing protocols such as OSPF and IS-IS.

WO 2004/001621 A3

BEST AVAILABLE COPY

WO 2004/001621 A3



Published:

— with international search report

(88) Date of publication of the international search report:
12 February 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/19674

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06F 15/173
US CL : 709/238, 239, 240, 241

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 709/238, 239, 240, 241

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 2003/0043756 A1 (REYNDERS et al) 06 March 2003 (06.03.2003), see entire document, especially abstract, page 1 paragraph 4, page 2 paragraph 16, page 3 paragraph 33 and page 4 paragraph 38	1-9
Y,P	US 2002/0141345 A1 (SZVIATOVSKI et al) 03 October 2002 (03.10.2002), see entire document, especially page 2 paragraph 13 and paragraph 16, page 4 paragraph 36 and page 7 paragraph 80	1-9
A,E	US 2003/0172180 A1 (REYNDERS et al) 11 September 2003 (11.09.2003), see entire document	1-9

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

01 November 2003 (01.11.2003)

Date of mailing of the international search report

19 NOV 2003

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (703)305-3230

Authorized officer

Hosain T. Alam

Telephone No. (703) 305-3900

INTERNATIONAL SEARCH REPORT

PCT/US03/19674

Continuation of B. FIELDS SEARCHED Item 3:
EAST, GOOGLE.COM
Dijkstra, Fibonacci, OSPF, routing, shortest, path, route, etc.